<table>
<tr><td>FIA2 Student Experiment</td><td></td><td></td></tr>
<tr><td>1. Forming</td><td></td><td></td></tr>
<tr><td>A considered rationale for the experiment

1.1 Rationale</td><td>• Intro
  • Outline initial experiment (brief summary)
  • Description of results/relationship
  • Suggest issue with original experiment (precision/accuracy etc)

• Discussion of Variables
  • What variable could have affected the experiment?
  • One/two will be brief, outline effects of changing the variables
  • Go into detail about the last one - this will be the variable you will change in the new experiment (IV)
  • Add research on the effect of changing this variable
  • Include any equations AND physics theory/concepts that relate

• Lead into new experiment
  • Once variables have been discussed, this should naturally follow into the modifications and the RQ</td><td>In the original calorimetry experiment, students found the change in temp of a heated block of metal (100deg C) and water in a calorimeter. They recorded the initial temp of the metal and its mass, as well as the mass of water in the calorimeter, the water initial temp and the final temp of the block and water once thermal equilibrium had been reached. This data was then used to calculate and confirm the specific heat capacity of the metal.</td></tr>
<tr><td>Justified modifications to the methodology</td><td><table><tr><td>Modification</td><td>Justification</td></tr><tr><td>Redirect</td><td></td></tr><tr><td>Refine</td><td></td></tr></table></td><td>The modifications can be as suggested in the table or written as a paragraph, you do not need to have all three (redirect, refine, extend), just</td></tr>
</table>

1.2 Modifications	Extend	specify which one of these the suggested modification addresses. Justification: you will need to justify why the modification was made to the original experiment. you should specify how the modification will enable you to investigate the research question, enable more precise or accurate results
A specific and relevant research question 1.3 Research Question	• Independent variable • Dependant variable • Control variables (2)	Write as a question Start with "What is the relationship between (IV and (DV)..."
A methodology that enables the collection of sufficient and relevant data (no need to include as a sub heading - I will mark this from your results table)	• This will be your results table • Ensure consistent sig figs for data • Ensure precision of instruments noted • 5 data points for IV • 3 trials	
Appropriate use of genre and referencing conventions (no need to include as a sub heading - except	• Do at end • paragraphs • Enter in text citations for relevant scientific concepts • Use scientific papers, not journal articles/wiki etc	

<table>
<tr><td>Reference section at end of report)</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>2. Finding</td><td></td><td></td></tr>
<tr><td>Considered management of risks / ethical issues / environmental issues

2.1 Risk Assessment</td><td>
<table>
<tr><td>Hazard</td><td>Risk</td><td>Control</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Environmental</td><td></td><td></td></tr>
</table>
</td><td>Environmental = pollution/contamination of environment/rubbish/recycling etc</td></tr>
<tr><td>Collection of sufficient and relevant raw data

2.21 Raw Data</td><td>

This will be your results table
Ensure consistent sig figs for data
Ensure precision of instruments noted

<table>
<tr><td></td><td></td><td>DV (unit)</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>IV (unit)</td><td>trail 1</td><td>trial 2</td><td>trail 3</td><td>average</td><td></td><td>Ab. Unc.</td><td>% unc.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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</table>
</td><td>A table of data showing:

Min 5 data points with min 3 trails each
Average
Uncertainty in measuring instruments (+- min scale reading)
Significant figures based on measurement uncertainty
Absolute uncertainty (range ÷ 2)
Percent uncertainty (absolute uncertainty ÷ average)
Ensure to use standard units (kg/degC)

</td></tr>
<tr><td>thorough identification of relevant trends / patterns / relationship</td><td>Plot IV (x axis) vs DV (y axis)
Use excel and use "xy scatter graph"

Make sure you graph has:

Title
Axis labels
Units
Line of best fit (trendline)

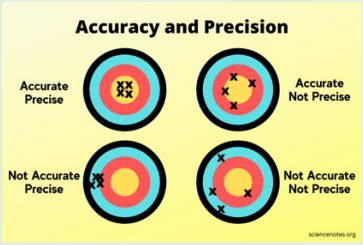
</td><td></td></tr>
</table>

s 2.22 Graph of raw data	- curved or straight? o Add in the equation and R^2 value for the trendline	
thorough identification of relevant trends / patterns / relationships 2.23 Discussion of raw data	This is the section where you can comment on what the relationship in the data is • Linear? • Exponential? • Power? • Etc Use the trendline on excel to get the R^2 value for these different trendlines - the one with the highest is the one you discuss!	Include the y=mx+c relationship
Fluent and concise use of scientific language and representation (no need to include as a sub heading)	This will be assessed in how you write your report • Headings • Paragraph writing • Concise (word limit) • Tables and figures annotated • Units and symbols correct	
3. Analysing		
Correct and relevant processing of data 3.1 Sample calculations	All calculations done should have an example here (can be a table) Averages Absulute uncertainty % uncertainty Standard Deviation SHC Etc	
thorough identification of relevant trends / patterns / relationships	This is where you calculate and show the theoretical relationship for your variables eg $C_{solution} = \frac{(m_{water} \times c_{water}) + (m_{salt} \times c_{salt})}{}$	

<table>
<tr>
<td>3.2 Theoretical Calculations</td>
<td>$m_{solution}$ $m_{solution}$</td>
<td></td>
</tr>
<tr>
<td>thorough and appropriate identification of the uncertainty of evidence

3.3 Uncertainty

Don't forget you can combine this with the reliability and improvements sections as a table here</td>
<td>How good was your data?

• Use the uncertainty data from your calculations to discuss how precise (spread from mean) your results are.
• This links closely to the previous section and so you can discuss the implications of the uncertainty here.
• The R^2 value (effectively how closely the data fits the trendline) x it by 100 to get a percentage
• The error bars - lots of error/not much error - more error at one point or at each end?</td>
<td> 

Example of combined uncertainty/reliability/improvements table:
<table>
<tr><th>Uncertainty</th><th>Effect of reliability</th><th>Improvement to reduce uncertainty and therefore increase reliability</th></tr>
<tr><td>Eg error bars were large for all data points, this shows that the experimental method may have had errors such as...</td><td>Reduces reliability as the true value is not well defined, this means that there is uncertainty as to the exact gradient of the line of best fit because ...</td><td>More trials; this would enable the elimination of outliers using the 5 figure method, this would result in lower uncertainty and therefore higher reliability because...</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
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<tr>
<td>thorough and appropriate identification of the limitations of evidence</td>
<td>These are the things that limited your ability to fully answer the RQ

• Was the range of values for the IV large enough? - could you see a clear trend?
• Would extending the values for the IV show a more clear relationship (either lower values or higher)? Why?</td>
<td>Example of combined limitations/validity/extensions table:
<table>
<tr><td>Limitation</td><td>Effect of Validity</td><td>Extension of experiment to reduce limitation</td></tr>
</table>
</td>
</tr>
</table>

3.4 Limitations Don't forget you can combine this with the validity and extensions sections as a table here	• Would taking more values for the IV (ie smaller increments etc) have improved the data/relationship? Why? • Would doing more trials have improved it? Why? You don't have to do all these, 2-3 is enough, but remember to say the why!	

		and therefore increase validity
The lower and upper bounds of the IV tested during the experiment are a limitation as the true relationship between the variables is not fully visible, the R^2 value of 0.87 demonstrates this.	Reduces the validity of the results because the true relationship is not known. The $y=mx^{-0.4}+c$ for the experimental data is close to the theoretical relationship of $y=mx^{-0.5}+c$. The difference demonstrates that the experimental methodology may have resulted in errors that led to this discrepancy, or there is some unknown factor not considered in the theoretical relationship, or that there is not a	Running the experiment with higher and lower values of the IV (*use values here*) would reduce the effects of the limitation and therefore enable a more full expression of the true relationship, thus increasing the validity of the results.

		broad enough set of data to fully see the full relationship.
4. Interpreting and Evaluating		
justified discussion of the **reliability** of the experimental process 4.1 Reliability Don't forget you can combine this with the reliability and improvements sections as a table	Link these **directly** to the uncertainty that you discussed earlier • How did your methodology result in reliable data - use evidence from your data here! Uncertainty -> reliability Eg. How do your % uncertainty show that your results are reliable/unreliable?	
justified discussion of the **validity** of the experimental process 4.2 Validity Don't forget you	Discussion of how and why the limitations you specified earlier will result in your data being valid or not valid Limitation --> validity In this section you'll **also** be validating your result by comparing your experimental values to the theoretical / accepted values Plot your theoretical data as a graph and get the y=mx+c	Example of gradient comparison: Theoretical gradient vs experimental gradient % error calculation Comment on validity of results based on % error

can combine this with the validity and extensions sections as a table	Compare the gradient of this line with your y=mx+c from the experimental data Use % error = true (theoretical) value - experimental value x 100% true (theoretical) value You can then use this as a talking point validating your experimental results	
suggested **improvements** to the experiment that are logically derived from the analysis of evidence 4.3 Improvements Don't forget you can combine this with the reliability and improvements sections as a table	The improvements you suggest should link directly to the uncertainty and reliability you mentioned above Uncertainty -> reliability -> improvement Eg. % errors are all high -> means results are not very reliable -> run more trials to increase precision of results = more reliable	
suggested **extensions** to the experiment that are logically derived from the analysis of evidence 4.4 Extensions	The extensions you suggest should link directly to the limitations and validity you mentioned above Limitation / validity -> extension Eg. Limitation in the range of IV values (not low enough to see clear pattern) -> extend range of IV values (0.1m, 0.05m etc) % error between experimental value for g (from data) and accepted value (9.81) is high -> conduct more trials / extend range of IV / more precise timing	

Don't forget you can combine this with the validity and extensions sections as a table	(video/light gates) etc	
justified conclusion/s linked to the research question 4.5 Conclusions	• Restate the RQ • State that the RQ was answered - explain what the relationship was that you found (equation) • Summarise the process for changing raw data into linearised data (only if present) • Give your experimental relationship and the comparison with theoretical / accepted relationship • Summarise why your value is close/not close to the accepted value • Summarise how the experiment could be improved to improve reliability and extended to improve validity	
5. References		Marked as part of Forming section
Appropriate use of genre and referencing conventions 5.1 References	Make sure to use in text citation and appropriate referencing (Harvard/APA) Eg - Citations As noted by Munroe (2025), the result is that both the CMBR and supernova methods of calculating the age of the universe disagree, leaving a so called "crisis in cosmology" (Cox et al, 2017) Eg References Cox, B., Penrose, R. & Munroe, G. (2017). *The future of the start of time*. Oxford University Press, London. Munroe, G. (2025). *Why is the start*	

	date for the universe unknown? Oxford University Press, London.	